

REMARKS

Upon entry of the Amendment, Claims 1-26 will be pending in the application.

Claim 1 is amended to recite “an adhesive film constituted essentially by a silicon-based compound having an aromatic ring in a molecule of said silicon-based compound having a specific dielectric constant of 2.5 to 2.6”. Support can be found, for example, at page 13, lines 13-17.

Support for new Claim 25 can be found, for example, at page 14, lines 13-16; and Fig. 6A - element 120.

Support for new Claim 26 can be found, for example, at page 14, line 16 to page 15, line 1; and Fig. 6B - element 121.

No new matter is added.

Entry of the Amendment along with reconsideration and review of the claims on the merits are respectfully requested.

Formal Matters

Applicant has elected Claims 1-13 (directed to a semiconductor device), and the Examiner has withdrawn from consideration Claims 14-24 (directed to methods of manufacturing semiconductor devices).

Applicant appreciates that the Examiner has acknowledged Applicant's claim for foreign priority and receipt of the priority document, and appreciates that the Examiner has reviewed and considered the references cited in the Information Disclosure Statement filed August 25, 2003.

Objections to Specification and Claims

A. The Examiner has objected to the title of the application.

In response, Applicant amends the title to recite “SEMICONDUCTOR DEVICE WITH INTERLAYER DIELECTRIC FILM AND MANUFACTURING METHOD THEREOF”.

B. The Examiner has objected to Claim 12 for reciting “said metal diffusion barrier”.

In response, Applicant amends Claim 12 to recite “~~said~~ a metal diffusion barrier”.

Accordingly, Applicant respectfully requests reconsideration and withdrawal of the objections to the title and Claim 12.

Claim Rejections - 35 U.S.C. § 103

A. Claims 1-7 and 9-11 are rejected under 35 U.S.C. § 103(a) as assertedly being unpatentable over Lee (US 2003/0067077) in view of Lauterbach et al (US 6,313,517), for the reasons given in the Office Action.

Regarding claims 1-3 and 9, the Examiner cites Lee (Fig. 1I) as disclosing a semiconductor device comprising a semiconductor substrate and an interlayer dielectric film formed on the semiconductor substrate, the interlayer dielectric film including a lamination consisting essentially of an adhesive film made of benzocyclobutene polymer (BCB) having benzene ring in its molecule, and a low dielectric constant film constituted essentially by an organic low dielectric constant material having a specific dielectric constant not greater than 4.

The Examiner recognizes that Lee does not disclose that the adhesive film is a silicon-based compound. However, the Examiner asserts that one skilled in the art would recognize that

the adhesive film of Lee would be formed by a silicon-based compound because it is made of a benzocyclobutene unit (BCB) in its molecule, as taught by Lauterbach.

B. Claims 12-13 are rejected under 35 U.S.C. § 103(a) as assertedly being unpatentable over Lee and Lauterbach et al as applied to claim 10, above, and further in view of Aoki et al (US 6,787,480), for the reasons given in the Office Action.

C. Claims 1-12 are rejected under 35 U.S.C. § 103(a) as assertedly being unpatentable over Barth et al (US 2004,0173908) in view of Lee (US 2003/0067077), for the reasons given in the Office Action.

Regarding claims 1-3 and 9, the Examiner cites Barth (Fig. 2) as disclosing a semiconductor device comprising a semiconductor substrate and an interlayer dielectric film formed on the semiconductor substrate, the interlayer dielectric film including a lamination consisting essentially of an adhesive film and a low dielectric constant film constituted essentially by an organic low dielectric constant material having a specific dielectric constant not greater than 4 and contacting the adhesive film.

The Examiner recognizes that Barth does not disclose that the adhesive film a silicon-based compound of BCB having an aromatic ring. However, the Examiner cites Lee (Fig. 1I) as teaching an interlayer dielectric film including a lamination consisting essentially of an adhesive film constituted essentially by a silicon-based compound of BCB having a benzene ring, and an organic low dielectric constant film having a specific dielectric constant not greater than 4 and contacting the adhesive film.

The Examiner asserts that it would have been obvious to form the adhesive film of Barth with the material as set forth above because as taught by Lee, such BCB adhesive layer would

provide a good adhesion to the metal wiring layer/organic dielectric layer and would prevent a crack issue.

Applicant responds as follows.

As previously note, Applicant amends Claim 1 to recite “an adhesive film constituted essentially by a silicon-based compound having an aromatic ring in a molecule of said silicon-based compound having a specific dielectric constant of 2.5 to 2.6”. Furthermore Applicant amends Claim 1 to replace “formed on” with “formed above” for clarification.

Regarding the rejection of Independent Claim 1 based on either the combination of Lee with Lauterbach or Barth with Lee, Applicant respectfully traverses the rejections on the basis that none of the references to Lee, Lauterbach, and Barth discloses or teaches at least the element of “an adhesive film constituted essentially by a silicon-based compound having an aromatic ring in a molecule of said silicon-based compound having a specific dielectric constant of 2.5 to 2.6”.

The Examiner cites Lee as disclosing “an adhesive film 118 made of benzocyclobutene polymer (BCB) having benzene ring (aromatic ring) in its molecule (par. [0019])” (see Office Action mailed December 1, 2004; bridging paragraph of pages 2-3). However, the Examiner points to Lauterbach for teaching “that the adhesive film 118 of Lee would be formed by a silicon-based compound because it is made of a benzocyclobutene unit (BCB) in its molecule, as taught by Lauterbach (column 3, lines 50-67 through column 4, lines 1-16).” (see page 3, second full paragraph).

Applicant kindly points out that Lee only discloses a benzocyclo polymer having a dielectric constant of about 2.7 (see page 2, paragraph [0019]). Thus, Lee, and the combination

of Lee with Lauterbach, fails to disclose or teach the dielectric constant range as presently claimed.

The Examiner cites Barth as disclosing “an adhesive film 118 (par. [0033])” (see page 4, last full paragraph), but recognizes that “Barth does not disclose that the adhesive film 118 is a silicon-based compound of BCB having an aromatic ring.” (see page 5, first full paragraph). The Examiner asserts that Lee makes up for Barth’s deficiencies.

However, Applicant kindly points out again that Lee only discloses a benzocyclo polymer having a dielectric constant of about 2.7 (see page 2, paragraph [0019]). Thus, Lee, and likewise the combination of Barth with Lee, fails to disclose or teach the dielectric constant range as presently claimed.

On the other hand, Applicant has achieved the present invention by recognizing that although the BCB layer can be formed by spin coating or other methods, employment of plasma polymerization ensures a specific dielectric constant of 2.5 to 2.6 and ensures that the BCB layer provides a higher durability against thermal degradation than that formed by spin coating. Specifically, the BCB layer formed by spin coating is not degraded under up to approximately 350°C atmosphere, while the BCB layer formed by plasma polymerization is not degraded under up to approximately 400°C atmosphere (see page 12, lines 14-21). The plasma-polymerized BCB layer has a specific dielectric constant of 2.5 to 2.6, which is lower than that of a BCB layer formed by thermal polymerization (see page 12, lines 13-16). Furthermore, it has been proven that the BCB layer formed by plasma polymerization provides a high durability against thermal degradation at a temperature of not less than 400°C, as well as increased chemical stability and sufficient mechanical strength (see page 13, lines 3-7).

Applicant submits that the dependent Claims 2-13 are patentable for at least the same reasons as given above for the patentability of independent Claim 1.

Accordingly, Applicant respectfully requests reconsideration and withdrawal of the obviousness rejections.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

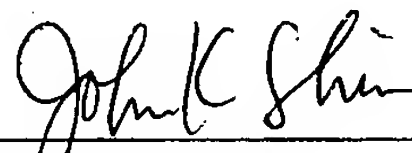
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